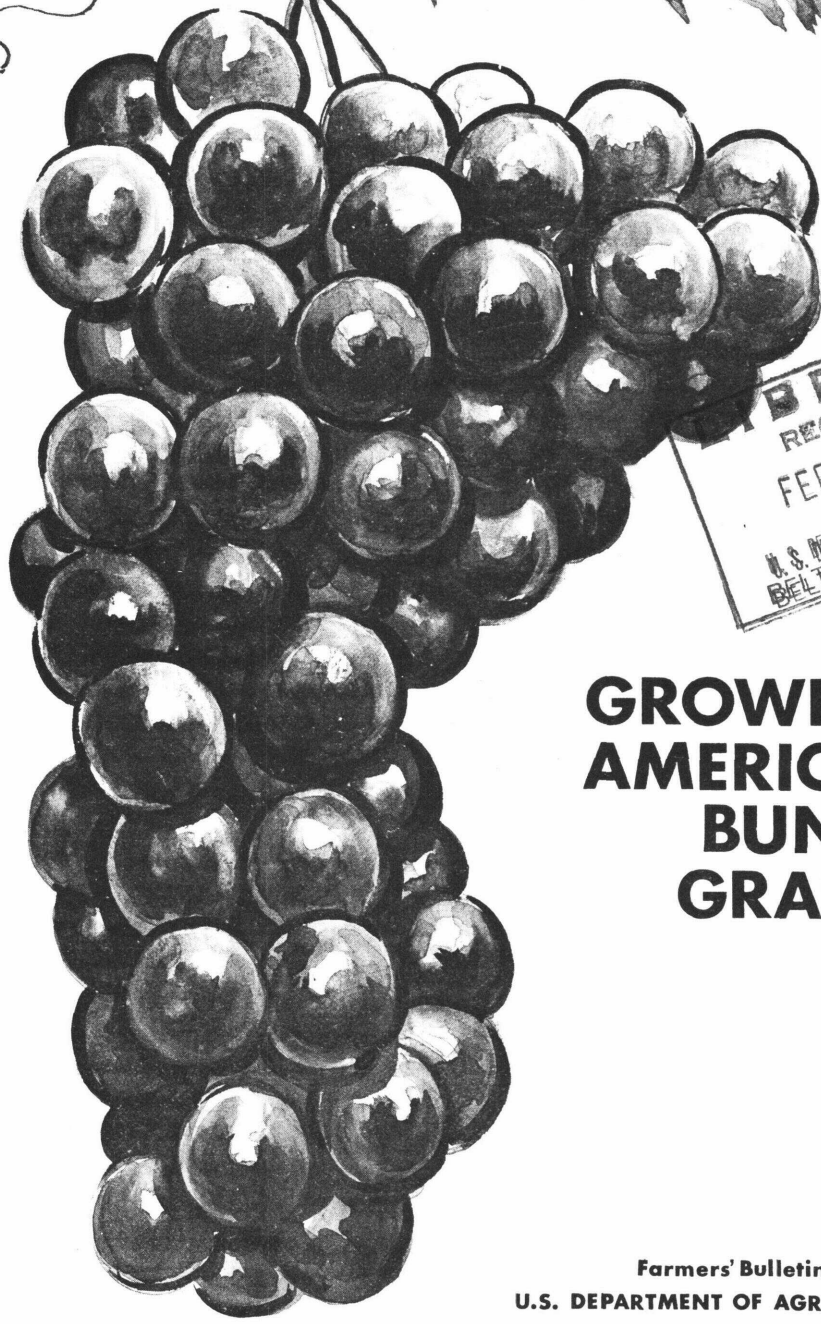


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GROWING AMERICAN BUNCH GRAPES

Farmers' Bulletin No. 2123
U.S. DEPARTMENT OF AGRICULTURE

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Growing

American Bunch Grapes

Prepared by Crops Research Division, Agricultural Research Service

American bunch grapes are the only type suitable for growing in most parts of the United States. Other types of grapes—vinifera (European or Old World grapes) and Muscadine—are more adapted to particular regions.

Bunch grapes are an important commercial fruit and also one of the most popular and extensively grown fruits in home plantings. They are easy to grow, bear early and regularly, and are small but long-lived plants. Insects and diseases are usually easily controlled.

The grapes are grown for fresh fruit and for processing (wine, juice, jams, jellies, and frozen products).

MAJOR COMMERCIAL- PRODUCTION AREAS

American bunch grapes are grown commercially in at least three-fourths of the States, but most of the commercial crop is produced in a comparatively few well-defined districts.

The major commercial areas are along the eastern and southern

shores of Lakes Michigan, Erie, and Ontario; the Finger Lakes section of New York; the lower Hudson River Valley; the south-central section of Washington State; the Ozark section of Arkansas and Missouri; and the Missouri River Valley in Nebraska, Kansas, Iowa, and Missouri.

The above plantings are almost exclusively of the Concord variety of American bunch grapes.

CLIMATE AND SOIL

Varieties of American bunch grapes are adapted to most climatic conditions. Growing of the grapes is limited or entirely unsatisfactory only in—

- Arid sections without irrigation. Production is often limited in the West and Southwest by lack of rainfall or water for irrigation.

- Locations with very short growing seasons. At least 170 frost free days are required for proper maturity of the Concord variety.

- Locations with extremely severe winter temperatures.

- Areas having high temperatures and extremely high humidity.

ties. The grapes are susceptible to several diseases which thrive under hot, humid conditions.

The major commercial areas are located where (1) the growing season is 150 to 180 days, (2) the relative humidity is low, and (3) summer rains do not occur often but soil moisture does not become critically deficient. Rainfall near the time of maturity can adversely affect the quality of the fruit and may cause the fruit of certain varieties to crack, resulting in serious losses.

Grapes will grow in a great many different soils. The fertile, deep, and well-drained loams are best, but soils that contain sand, gravel, shale, slate, or clay can be used. Soils underlain with hardpan are not well adapted, nor are those that are shallow and underlain with gravel or sand. Avoid extremely wet or extremely dry soils. Vine growth is usually improved by organic matter in the soil.

All grape varieties are not equally adapted to acid or to alkaline soils, but varieties or rootstocks can be selected that are highly tolerant to either of these conditions. Drainage is a primary requirement of grapes; if the land is not well drained, it is not good grape soil regardless of other desirable soil characteristics.

The soil exerts considerable influence on the crop. Excessively rich soils and those with a high organic content produce a heavy but late-maturing crop with a low sugar content. Light soils tend to produce light yields of early-maturing fruit with a high sugar content and a

comparatively weak vine growth. The effects of the soils on the fruit quality are reflected in the quality of the juice and wine.

VARIETIES

Most American bunch grape varieties originated from the species *Vitis labrusca*, or the fox grape. Varieties of this species and its hybrids are grown almost exclusively in commercial plantings.

Varieties of the species *V. riparia*, or the frost grape, are adapted to the more northerly areas. They are extremely cold hardy and mature fruit in a very short growing season. Many are excellent wine varieties.

Most of the varieties adapted to the South belong to the species *V. champini*, *V. lincecumii*, *V. rupestris*, and *V. bourquiniana*.

Many varieties are hybrids of two or more species. American species have been crossed with the vinifera grape to develop bunch grape varieties with the superior fruit quality, larger berries, and larger fruit clusters of the vinifera. However, these varieties also have the weaknesses of the vinifera. They are less cold hardy and less resistant to diseases, phylloxera, and nematodes than are the American fox and frost grapes.

Concord is the leading commercial variety. It is also the standard by which both the vine and fruit of other varieties are judged. Other important commercial varieties include Niagara, Delaware, Catawba, and Campbell Early.

Varieties suitable for growing in the different regions indicated in

figure 1 and most frequently recommended for home planting include:

Region

- 1----- Beta, Blue Jay, Red Amber.
- 2----- Brighton, Catawba, Concord, Delaware, Fredonia, Moore Early, Niagara, Ontario, Portland, Seneca, Van Buren, Worden.
- 3----- Brighton, Catawba, Concord, Delaware, Fredonia, Golden Muscat, Lenoir, Niagara, Norton, Portland, Sheridan, Worden.
- 4----- Blue Lake, Catawba, Champanel, Concord, Delaware, Ellen Scott, Extra, Fredonia, Lenoir, Niagara.
- 5----- Beta.
- 6----- Campbell Early, Concord, Delaware, Ellen Scott, Golden Muscat, Niagara, Worden.
- 7----- Campbell Early, Concord, Golden Muscat, Niabell, Niagara, Worden.
- 8----- Concord, Niabell.

Following are descriptions of the listed varieties. Fruit color is indicated: (B)=blue or purple; (R)=red; and (W)=white or greenish.

Beta (B).—Very cold-hardy variety. Small fruit and clusters. Fruit high in acid and sugar and used primarily for juice and jelly. Vine vigorous and productive.

Blue Jay (B).—Cold-hardy variety, good for juice and jelly and when fully ripe for table use. Requires cross pollination.

Blue Lake (B).—Adapted to Florida. Small fruit and medium-large clusters. Unusual aromatic and spicy flavor suitable for juice and jelly. Does not ship or store well.

Brighton (R).—Midseason variety of excellent quality. Medium-

sized fruit and clusters. Requires cross pollination.

Campbell Early (B).—Commercial variety in the Pacific Northwest (synonym "Island Belle") and in the Ozarks. Large fruit and clusters. Fruit very fine in quality when grown under ideal conditions. Vine only moderately vigorous and frequently sets a "stringy" fruit cluster.

Catawba (R-B).—Large fruit and clusters. Very pleasing and distinctive flavor. Used primarily for wine, but also for dessert and juice. Variety ripens about 2 weeks later than Concord and cannot be grown as far north.

Champanel (B).—Late variety grown to a limited extent in the South. Vines excessively vigorous and long-lived in that area. Production fair. Large, extremely juicy fruit high in acid and low in sugar content.

Concord (B).—Leading commercial variety. Widely adapted, hardy, disease resistant, and productive. Large fruit and medium-large clusters. Fruit highly aromatic, has a "foxy" flavor, and medium in acid and sugar content.

Delaware (R).—Standard of quality wherever grown. Highly prized for dessert and for sparkling wine. Small fruit and clusters. Fruit high in sugar content and medium in acid. Vine rather weak and not so hardy as Concord, but disease resistant and productive in relation to its vigor.

Ellen Scott (B).—Late variety of excellent quality. Large fruit and clusters. Fruit very tender and juicy. Vine vigorous, but highly

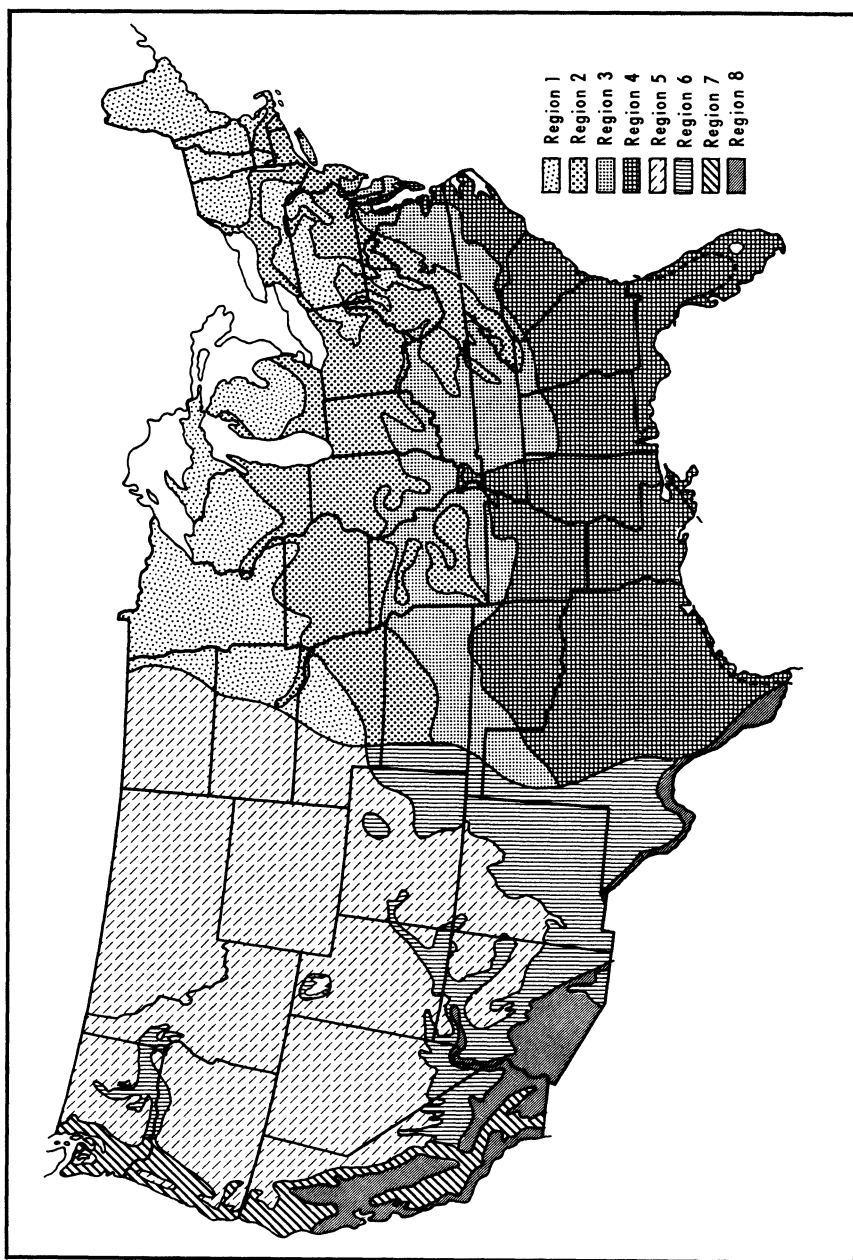


Figure 1.—Varieties of American bunch grapes adapted to the different regions shown are indicated in the text.

susceptible to anthracnose. Grow only in comparatively dry regions.

Extra (B).—Grown throughout the Southeastern States. Large fruit and medium-large clusters. Distinctive flavor typical of the wild post oak (*V. linsecumi*) grapes.

Fredonia (B).—One of the best of the Concord-type grapes. Large fruit and medium-sized, well-filled clusters. Variety ripens 2 to 3 weeks earlier than Concord, but is not so widely adapted nor so consistently productive.

Golden Muscat (W).—Late variety very popular for home gardens. Large, well-filled clusters of yellow fruit with a distinctive, although sometimes mild, and pleasing muscat flavor. Vines vigorous and productive.

Lenoir (B).—Small fruit borne in large clusters. Superior quality for juice and wine. Vines vigorous and extremely productive. Variety requires long growing season, is tender to winter cold, and is highly susceptible to diseases (anthracnose and black rot); adapted only to comparatively dry regions.

Moore Early (B).—A Concord type that ripens about 2 weeks earlier than Concord. Vine not so productive nor so vigorous as Concord. Fruit not so good in quality and often cracks badly.

Niabell (B).—Large-fruited variety introduced in California for juice and table use.

Niagara (W).—Most popular white-fruited variety. Large fruit and clusters. Fruit moderately acid, medium in sugar content, and has a

strong "foxy" flavor. Not a high-quality variety, but it sells well in the region where fox grapes are native, because of its size and beauty.

Norton (B).—Small fruit of exceptionally fine quality for juice and wine. Variety is hardy, disease resistant, and vigorous, but is comparatively slow in growth and difficult to root.

Ontario (W).—Very early, productive variety. Fruit of excellent quality for table or jelly use, but does not keep or ship well.

Portland (W).—Probably the best very early variety for home planting. Not adapted to commercial plantings because the skin is very tender and tears badly in handling. Large fruit and clusters. Good quality for "out of hand" eating.

Red Amber (R).—Very hardy variety, but may need winter protection if grown in exposed sites in region 1. Sweet, medium-sized fruit, suitable for fresh or processed use.

Seneca (W).—Early, fairly productive, but not vigorous variety, with near-vinifera quality. Small fruit and large clusters. One of the best of the table grapes. Requires careful pruning and spraying.

Sheridan (B).—Large, compact clusters of high-quality fruit. Fruit keeps well in storage. Variety requires proper pruning and favorable location for good fruit maturity. Ripens later than Concord.

Van Buren (B).—Very early Concord-type variety. Vigorous and productive vine. Medium-sized fruit

Direct Producers

The selections known as direct producers or French hybrids are hybrids between the European (*Vitis vinifera*) and American grapes. They often have the very fine qualities of vinifera grapes, but also many of the weaknesses. They were developed in Europe for phylloxera resistance and can be grown on their own roots where phylloxera is a problem.

There is very little acreage in these grapes in this country; they are in demand mostly for trial, by amateur grape growers and wine-makers. They are usually identified by the name of the originator and the selection number—for example, Seibel 1000.

and clusters. Fruit not as aromatic as that of Concord.

Worden (B).—Concord seedling that ripens about 10 days earlier than Concord. Vigorous and productive vine. Fruit of good quality, but sometimes cracks badly.

VINEYARD

Selection of Site

For the vineyard, select a relatively frost-free site with well-drained soil. Level or gently sloping land that is somewhat elevated is best. Steep slopes are subject to erosion.

Sites to the south and east of large lakes are very favorable. Large

bodies of water change temperature slowly and have a moderating effect on the surrounding area; summers are cooler and winters are warmer. On such sites, plant growth may be retarded enough in the spring to avoid injury from late frosts, and frosts are delayed in the fall.

Grapes blossom and mature earlier on southern and eastern slopes than on northern slopes. However, on the colder northern slopes, growth may be retarded enough in the spring to avoid injury from late frosts. Western slopes are exposed to prevailing winds, which in some areas may be strong enough to cause damage. Where the rows run east and west as on a northern or southern slope, prevailing winds from the west dry the dew and rain from the foliage quickly, which helps to prevent diseases.

Direction of the slope may be important at the northern limit of a variety's range where a few days' delay in ripening may cause a crop loss; elsewhere, it is a minor consideration.

Land Preparation

If the vineyard land has been in sod or has not been cultivated for some time, grow a row crop for at least one season before preparing the land for grapes.

Before planting the grapes, plow the land deeply and disk it until the soil is well pulverized.

Straight rows are desirable, but plant on the contour if necessary to prevent erosion. Where required, contour planting is well worth the

extra time required to lay it out. Your county agricultural agent or your local technician for the soil conservation district can advise on land preparation for contour planting.

PROPAGATION

American bunch grapevines are usually grown on their own roots—propagated from cuttings of the previous season's growth. However, rootstocks may be used to provide a root system resistant to phylloxera or nematodes or to increase the vigor of weak-growing varieties. Scion and rootstock may be joined by grafting or by chip budding.

Cuttings

Cuttings are usually taken from the previous season's growth. However, mallet cuttings—cuttings that bear a small portion, or heel, of the previous year's growth—root more easily (fig. 2).

Cuttings may be taken from prunings anytime during the dormant season, but if taken early there is less chance of the wood being winter injured.

Select well-matured wood at least one-third inch in diameter. Make the basal cut just below a bud. For varieties of the Concord type, select canes with buds 3 to 5 inches apart and make the cuttings at least three buds long. For weaker-growing varieties, such as Delaware, select canes with shorter joints and leave more buds per cuttings. To facilitate handling and bundling, make the

cuttings of a variety approximately the same length regardless of the number of buds.

Tie the cuttings in small bundles with all buds pointing in the same direction. Store the bundles in a well-drained trench or a cool cellar until time to plant in the nursery. Cover them with soil, sand, or sawdust to prevent the cuttings from drying out.

In the South, cuttings may be planted in the nursery anytime from fall to early spring; in colder areas, plant in early spring. Plant before

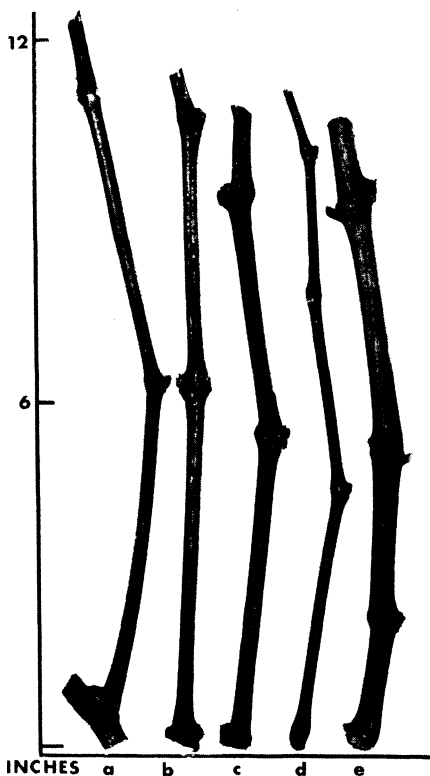


Figure 2.—*a*, Mallet cutting; *b* and *c*, good cane cuttings; *d*, thinner than optimum; *e*, thicker than optimum.

any root or shoot growth occurs on the cuttings.

The nursery soil should be well-prepared, well-fertilized, and free of weeds. Set the cuttings 4 to 6 inches apart in the rows, which may be spaced 2 to 4 feet apart. Plant the cuttings with one bud above ground and firm the earth around them. Where there may be alternate freezing and thawing, mulch cuttings set in the fall or winter to protect them from heaving.

Rootstocks

In general, bunch grapes do well on their own roots, as cuttings. However, under marginal conditions (poorly adapted soils, soil-borne diseases or nematodes, phylloxera-infested soils, weak varieties), they may grow better if grafted on special rootstock varieties.

Because results with rootstocks are dependent on so many factors, no general recommendations are possible. County agricultural agents can advise on the use of rootstocks and on grafting techniques.

TRELLIS CONSTRUCTION

The trellis consists of two or more wires attached to wood, concrete, or steel posts. Construction is essentially the same as for a sturdy wire fence.

Durable types of wood posts include black locust, Osage-orange, red cedar, white oak, and "fat" pine. Less durable types of wood may be treated with a preservative, such as

creosote or pentachlorophenol, to increase their durability.

Reinforced concrete and heavy steel posts are expensive, but are the most durable type. Steel posts must be heavy enough to resist bending in a strong wind when the foliage is thick. They are adapted only to soils heavy enough to hold them in line.

An occasional steel post among wood or concrete posts will ground the trellis and may prevent damage to the vines from lightning.

End posts should be longer and heavier than line posts and must be well braced. Failure of an end post weakens the entire trellis. Set end posts 3 feet in the ground and line posts 2 feet. In contour planting, line posts may require extra bracing.

No. 9 wire is ordinarily used for trellises, but the lower wires can be as light as No. 11. Staple the wires on the windward side of the posts. Do not drive the staples tight—allow the wires to slide under them to facilitate tightening. The wires should be tightened each spring before the vines are tied.

Space trellis posts within the row twice as far apart as the distance between plants. Vineyard rows are usually spaced 10 feet apart to allow free movement of cultural equipment without injury to the vines.

PLANTING

Grapes should be planted as soon as the soil can be worked in the spring so that they will be well established by the time the hot and dry summer weather arrives. Fall

planting allows the vines to start growth as soon as the weather permits, even though the soil may not be in condition to work.

In the South, vines may be planted as soon as they are dormant in the fall. In colder areas, fall-planted vines require mounding with earth to protect against frost heaving and winter damage. Because of this extra work and the possibility of the loss of vines, early spring planting is generally preferred north of Arkansas, Tennessee, and Virginia.

Set the strongest 1-year-old plants available. Two-year-old nursery plants are seldom worth the extra premium nurseries must charge for them.

Plant grapevines about the same depth that they grew in the nursery, and prune them to a single stem two or three buds long.

For most varieties, including Concord, space the plants 8 to 10 feet apart in the row. Less vigorous varieties, such as Delaware, may be spaced 7 to 8 feet apart. Vines in single-row plantings are set the same distance apart as those in a vineyard. They may be more vigorous than those in a vineyard, because of less competition for nutrients and moisture.

Set two vines between wooden posts. Do not set vines against the posts because the roots may be injured when the posts are replaced and the wood preservative in treated posts may be toxic to the plants. Where concrete or steel posts are used, the grape hoe is easier to use if a vine is set at each post and one in between.

Set vines directly under the trellis; vines out of line may be constantly injured during cultivation.

TRAINING AND PRUNING

Training and pruning are interdependent operations. Young vines are trained to a system of growth on the trellis or other support by some pruning. Mature vines are pruned to maintain the system of growth and to insure the production of good-quality fruit.

Knowledge of grapevine terminology is especially helpful when pruning:

Trunk (or cordon).—The main perennial part of the vine.

Shoots.—The current season's growth of young wood. Shoots originate from the buds on the spurs and arms and bear the leaves, flowers, and fruit. As they mature, they are termed canes.

Canes.—The mature shoots of the current season or the dormant growth of the preceding season. Most of the canes are pruned off during the dormant season.

Arms.—The canes that are left after pruning and that produce the fruiting shoots and canes. At the end of the growing season, they are usually removed completely and replaced by new arms for the following season.

Renewal spurs.—Canes pruned to two or three buds. New canes from these spurs are selected for arms the following season.

Training Systems

Four-Arm Kniffin

The four-arm Kniffin system (fig. 3) is the most popular one for bunch grapes. It gives good production, requires little summer tying, and is especially adapted to vigorous growing varieties.

The trellis consists of two wires—one 30 inches above the ground and the other 24 to 30 inches higher.

After the first growing season (during the dormant period), select the most vigorous cane for the trunk and tie it to the top wire. Cut the cane off above the wire and remove all other canes. If no cane is long enough to reach the top wire, tie the strongest one to the bottom wire, and extend it to the top wire the following season. If no cane is

long enough to reach either wire, cut the vine back to a single stem, two or three buds long, and start anew.

After the second (or third) growing season (during the dormant period), select four vigorous canes for the arms. Prune the canes to approximately 10 buds in length (see "Time and Amount of Pruning," p. 17), lay them down along the wires, and tie them. Cut four other canes back to two or three buds in length for renewal spurs. Remove all other canes.

Each winter thereafter, replace the arms with canes from the renewal spurs, and leave new renewal spurs.

You can increase yield and hasten maturing of the fruit slightly by raising the height of the trellis to

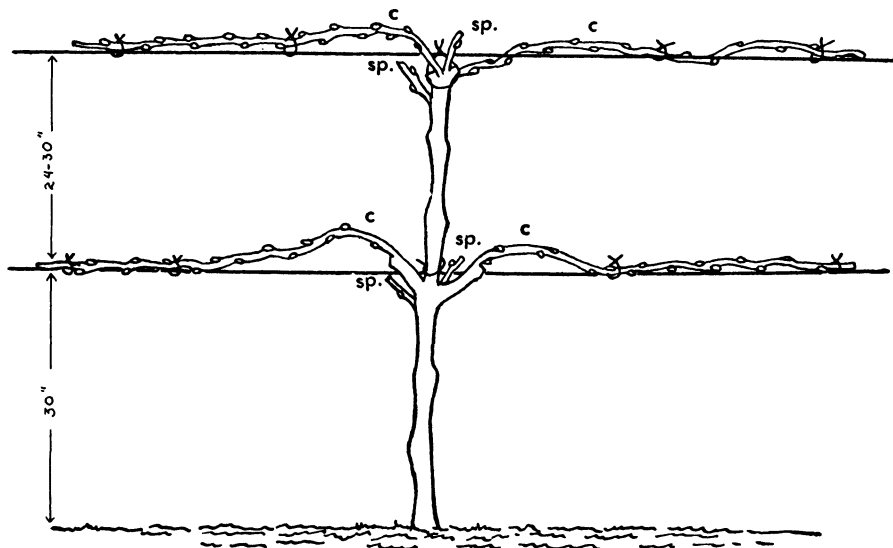


Figure 3.—The four-arm Kniffin training system is the most popular one for American bunch grapes.

6 feet or more and increasing the space between the wires. This exposes the growth to more sun and light. Where the growing season is very short, this modification could make the difference between a crop and a failure.

Umbrella Kniffin

Excellent quality fruit can be produced under the umbrella Kniffin system (fig. 4). And with vigorous vines, yield can be as great as that under other high-yielding systems.

The trellis is the same as that for the four-arm Kniffin system.

Train the vine to a single trunk

extending to the upper wire. After the second growing season (during the dormant period), select two to four canes growing from near the top of the trunk for arms. Prune them to 10 to 20 buds in length, depending on the number of arms left. Cut back two other canes to two or three buds in length for renewal spurs. Loop the arms over the top wire, bring them down obliquely to the bottom wire, and tie them. The shoots that develop during the next growing season droop off to the sides.

Each winter thereafter, replace the arms with canes from the renewal spurs.

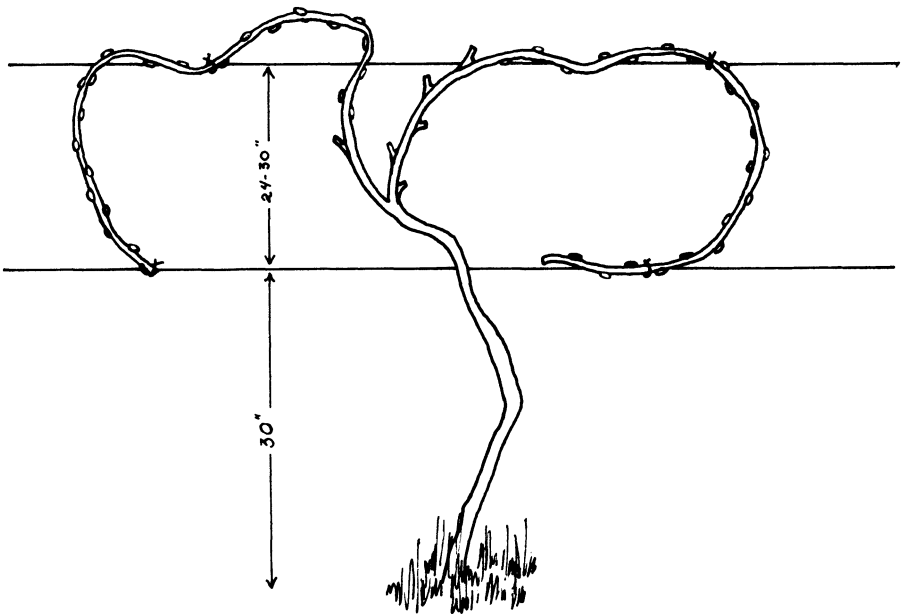


Figure 4.—The umbrella Kniffin training system can give good yield and excellent quality fruits.

Munson

The Munson system (fig. 5) is used in home plantings and in experimental vineyards, but very little in commercial plantings. It is particularly suitable for humid climates, because the fruit is produced high above the ground where it is less subject to injury by diseases.

The trellis consists of three wires strung in the shape of a wide V. Two wires are attached to the outer edges of cross arms 18 to 24 inches wide and 5 feet above the ground. The third wire is attached to the posts, 6 to 8 inches lower.

Train the vine to a single trunk extending to the lower wire. After the second growing season (during the dormant period), prune to two or more canes (arms) and two renewal spurs. Tie the arms along the

lower wire. As the shoots develop the next growing season, distribute them over the upper wires, allowing them to hang down.

Each winter, replace the arms with canes from the renewal spurs, and leave new renewal spurs.

Modified Chautauqua

The modified Chautauqua system may be used where tender varieties of grapes require winter protection.

The trellis consists of two or three wires. The bottom wire is 12 inches above the ground and the middle and top wires are 16 and 32 inches higher, respectively.

After the first growing season (during the dormant period), select a large, vigorous cane for the trunk. Cut it back to about 30 inches and remove all other canes. Lay the

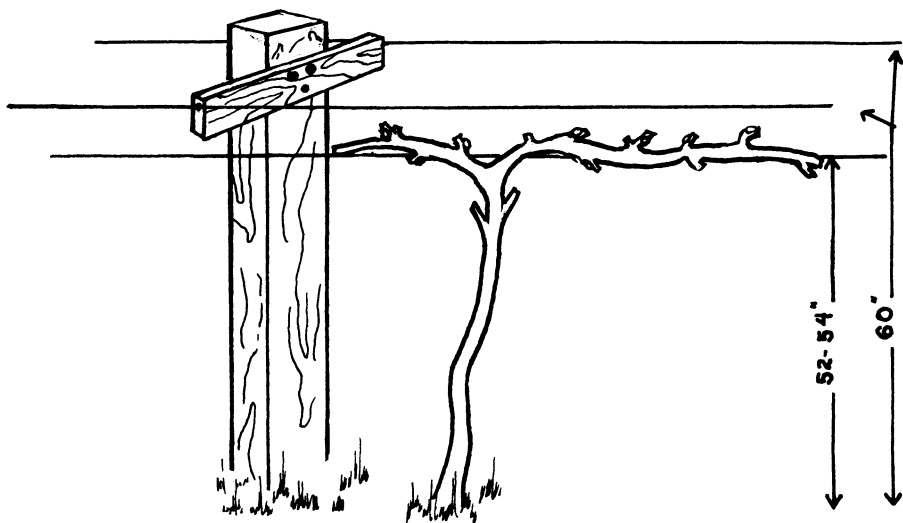


Figure 5.—The Munson training system is especially suitable for humid climates.

trunk on the ground and cover it with 6 to 8 inches of soil to protect it during the winter.

In the spring, uncover the trunk and tie the end of it at an angle to the bottom wire of the trellis (see fig. 6). As shoots develop from the trunk during the summer, tie them to the upper wires.

After the second growing season (during the dormant period), untie the vine from the trellis. Prune the current season's growth to short spurs, two buds long, except retain the cane nearest the tip of the trunk to form an extension to the trunk. Lay the vine on the ground and cover it with soil.

Repeat the procedure in the above paragraph after each growing season thereafter. Extend the vine trunk to about 7 feet.

Geneva Double Curtain ¹

The Geneva Double Curtain system was developed for training vigorous vines of such varieties as Concord, Delaware, Niagara, and Catawba. Under this system, the shoots and leaves receive more exposure to the sun. This results in higher yield and better quality fruit.

Trellis construction is shown in figure 7. The important feature is the two top or cordon wires. One vine can be trained for 16 feet along

¹The Geneva Double Curtain training system was developed by the Agricultural Experiment Station at Geneva, N.Y., for Concord and other bunch-grape varieties popular in New York. More information about this system may be obtained from the Experiment Station.

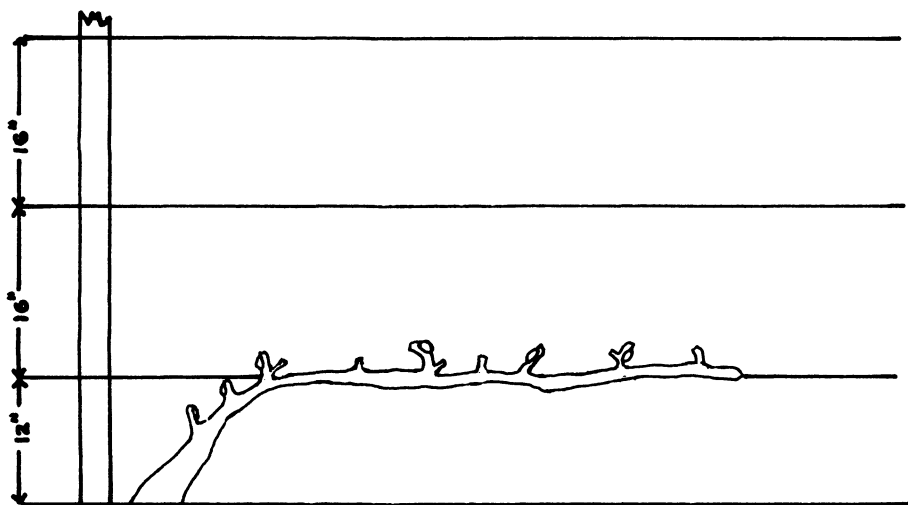


Figure 6.—The modified Chautauqua training system may be used where grapevines require winter protection.

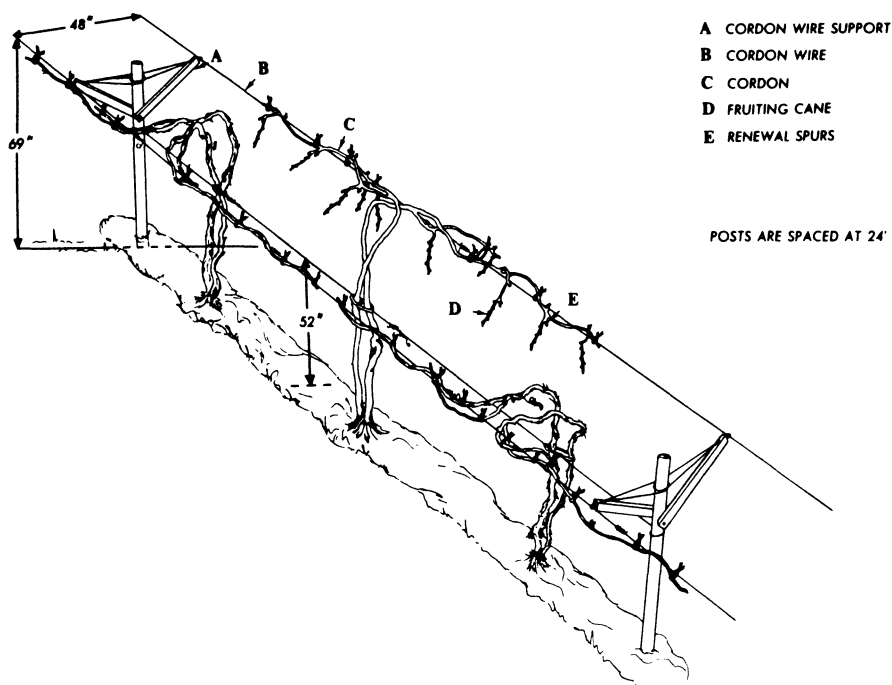


Figure 7.—Under the Geneva double curtain training system, the shoots receive more exposure to the sun than under other systems. (Drawing from Bulletin 811, "The Geneva Double Curtain for Vigorous Grape Vines," New York Agricultural Experiment Station, Geneva.

one of these wires, while an adjacent vine in the same row can be trained for 16 feet along the other wire. Trellis space per vine is about double that under other training systems.

The vine trunk is trained to the lower wire (two trunks per vine are recommended for better utilization of the 16 feet of trellis space). From the trunk (or trunks), branches or cordons are developed and extended along the two cordon wires.

Five-bud spurs and one-bud renewal spurs are maintained on each branch or cordon. If allowed to

grow normally, shoots from these spurs would form a broad and dense canopy of foliage. Each year the shoots must be positioned by hand so that they will grow in a vertically downward direction to form a curtain of foliage suspended from each cordon wire. The final effect is a double curtain of foliage from each row of grapes.

The Geneva Double Curtain system gives increased yield both per shoot and per vine with no delay in maturing of the fruit. Also the fruit is in good position for harvesting either by hand or by machine. The

increases in returns possible can offset the additional cost involved in building the trellis and positioning the shoots each year.

Arbors

Arbors are seldom used in commercial plantings, but they are often constructed around homes to give shade and fruit.

When the vines are pruned to arms well spaced over the trellis, yields are very good. For quicker and more uniform covering of the arbor, the vines should be pruned to short spurs two to three buds long, although this procedure may reduce the size of the crop.

Time and Amount of Pruning

Grapevines are pruned annually to limit the number of fruit-producing buds. Overproduction of fruit adversely affects vine growth and fruit size and quality.

Prune the vines during the dormant season. Where winter temperatures are low enough to injure the canes, wait until late winter or early spring when you can select uninjured canes for fruiting. Pruning prior to severe freezes can increase winter injury to grapes.

Where winters are relatively mild, prune anytime during the dormant season when the temperature is above freezing. When frozen, canes are brittle and easily broken.

Vines pruned late in the spring will "bleed" freely, but this is not injurious. Vines pruned just before growth starts or after the buds swell

leaf out a little later than those pruned earlier. While the delay in leafing out may be sufficient to avoid injury from late frosts, vines are hard to prune and tie after growth starts without destroying many of the buds.

Proper pruning is essential for consistent yields and good-quality fruit. If underpruned, vines become weaker and produce smaller-sized clusters and fruit. If overpruned, they become excessively vegetative. Vigorous, medium-sized canes produce more and better fruit than weak or excessively vigorous ones, and the buds in the middle portion of a cane produce more and better fruit than those on either end.

Less experienced pruners should follow the method of weighing wood and counting buds in pruning. For Concord and similar varieties, rough-prune the vine to the training system selected, leaving a surplus of buds. Weigh the wood removed. For the first pound of wood removed, between 30 and 40 buds are left on the vine; for each additional pound of wood removed, 8 more buds are left on the vine. Finish pruning the vine to the proper number of buds.

Even experienced pruners should weigh wood and count buds on an occasional vine to guide and check themselves in pruning.

Modifications in pruning may be necessary because of differences in varieties and in growing conditions. For example, grapevines under irrigation in Washington State are more vigorous than vines in the East. Consequently, 60 buds are left

on the vine for the first pound of the past year's prunings removed and 20 buds for each additional pound removed. In Minnesota, the small-clustered Beta variety produced much greater yields when 70 to 90 buds were left than when 40 were left. Large-clustered varieties, such as some of the French hybrids, should be pruned to as few as eight buds for the first pound of prunings removed plus four buds for each additional pound.

Tying Fruiting Arms

In the four-arm Kniffin and the Munson training systems, the arms may be—

- Wrapped firmly around the wire from the trunk outward and tied.
- Looped loosely around the wire once and tied.

- Tied parallel to the wire.

If the arms are looped loosely around the wire or are tied parallel to it, use extra ties at the base of the arms or at the trunk.

In the umbrella Kniffin and the modified Chautauqua training systems, the arms are pulled across the proper wire and tied.

Tie the arms before the buds start to swell, because the buds are easily rubbed or knocked off. Tie tightly only at the end just back of the last bud which should be rubbed off. Leave the other ties loose. Use binder twine or other material that will last and retain its strength for several months. Tie a knot that will not slip.

Renewing Trunks

If a trunk is misshapen, damaged, or diseased, it is generally faster to develop a new trunk from the existing roots than to replace it with a new vine. If the old trunk is diseased, immediate removal is advisable. Otherwise, it can continue to bear a crop while the new trunk is being developed.

Train a strong sprout or sucker from the base of the old trunk to the trellis as though it were the cane of a young vine. After 2 years the framework should be established. Then greatly restrict the number of canes from the old trunk to permit the new framework to produce a good crop. The following winter (the third) remove the old trunk completely.

Treatment of Frost-Injured Vines

A late frost may severely injure the new growth of grapes. If this happens, remove all new growth—injured and uninjured parts. The buds of grapes are compound, and when the first growth is removed a secondary bud normally develops and produces a partial crop. The crop is larger if the injury occurs when the primary growth is very short.

A few shoots on frosted vines may be uninjured. If only the injured shoots are removed, the uninjured ones will make fast growth. Very few secondary buds develop from partially stripped vines—complete stripping is necessary to force secondary growth. Partial stripping

results in ill-shaped vines that are difficult to prune satisfactorily the following winter. Usually, vines frosted enough to need some stripping should be stripped completely.

When the growth is long and only the tips and terminal leaves appear to be frost injured, the flower clusters may open in an apparently normal manner, then shed without setting much fruit. Under these conditions it is impossible to determine the exact degree of injury right after the frost. Therefore, if injury appears mild, it is safer not to strip. Such vines will produce a partial crop without stripping, and stripped vines never produce more than a partial crop.

SOIL MANAGEMENT

Cultivation

Grapes respond to cultivation, and vineyards are normally cultivated at least during the spring and early part of the summer.

Cultivate shallowly—3 to 4 inches deep—to avoid serious injury to the roots. For the first cultivation, use a bottom plow, rotary tiller, or a tandem disk. Then cultivate as necessary with a springtooth harrow to keep weeds down.

If used by an experienced operator, the grape hoe is excellent for cultivating within the grape row. It gets most of the weeds, leaving very few for hand hoeing. The power rotary hoe may also be used under the trellis.

In hillside vineyards subject to erosion, follow a system of trashy

cultivation. Keep some growth and trash on the land and keep the land rough enough to pocket and hold water. Cultivate only enough to prevent weeds from competing seriously with the vines. A tandem disk is excellent because it can be adjusted to loosen the soil without turning it.

Grapevines should be kept in vigorous condition. Weak vines set poor “stringy” fruit clusters and are unproductive. Lack of vigor is a common problem in vineyards. Cultivation and the use of nitrogenous fertilizers stimulate weak vines.

Excessively vigorous vines also set fruit poorly, even though they blossom freely. Restricting growth at blossoming time can increase the set of fruit. A fast-growing cover crop, such as oats or rye, will compete with the vines for plant nutrients and moisture and may restrict growth. Resume normal cultivation after the fruit is set. Lack of cultivation, reducing the amount of nitrogenous fertilizer applied, and leaving more fruiting wood also help to curb excessive vigor of vines.

Under some conditions it may be necessary to restrict growth in the fall so that the canes will mature properly to withstand winter temperatures. Also, restricting the growth of vigorous vines a few weeks before the fruit ripens often improves the quality of the crop. To restrict growth, sow a fast-growing cover crop during the summer.

Fertilizers

Fertilizer requirements will vary with the kind of soil. Soils may re-

quire a complete fertilizer (nitrogen, phosphorus, and potassium) or they may require only nitrogen and potassium or nitrogen alone. In the Southeastern States, the soils generally require a complete fertilizer.

In most areas, phosphorus benefits grapes very little, but it generally aids the growth of cover crops enough to warrant its use in vineyards.

Boron, zinc, and magnesium are helpful on the poor sandy soils in the coastal States of the East and South. In highly acid soils, lime may be necessary for the growth of legume cover crops.

Organic materials—barnyard manure, straw, hay, and grape pomace—can supply appreciable quantities of essential plant foods. Materials such as straw and sawdust, if not well rotted when applied, require additional applications of nitrogen.

County agricultural agents and State agricultural experiment stations can advise on fertilizing.

Cover Crops

Where vineyard land is intensively cultivated, cover crops should be grown to maintain the organic matter content of the soil.

The small grains, particularly rye and oats, are good winter cover crops, because they make good growth quickly. Ryegrass is sometimes grown, but grass crops do not add nitrogen to the soil.

Grow legumes as a winter cover crop in areas where adapted. Vetch is widely adapted. Crimson clover,

burclover, and blue lupine may be grown in the South.

Crops that are drill seeded are easier to clean out of the grape rows in the spring than those that are broadcast.

In some locations, summer cover crops, such as soybeans, buckwheat, millet, and cowpeas, are grown as an additional source of organic matter.

CHEMICAL WEED CONTROL

Weeds are difficult to remove from under the trellis with a grape hoe without some damage to the vines. A spray solution of DNBP fortified with diesel fuel oil may be used to control the weeds. Mix 2 pounds of DNBP (2 pints of any available formulation containing approximately 50 percent DNBP), 10 gallons of No. 2 diesel fuel oil, and 90 gallons of water.

For most effective control, spray three times per season. Make the first application when the weeds are 4 to 6 inches high. Make the succeeding applications at 3- to 4-week intervals when the weeds are again 4 to 6 inches high.

Spray a strip 2 to 3 feet wide under the trellis at a rate equivalent to 100 gallons per acre. If weed growth is heavy, increase the spraying rate to an equivalent of 150 gallons per acre.

In areas where temperatures exceed 90° F. for extended periods, vapors from DNBP may cause minor contact injury and marginal leaf discoloration. It is advisable to

Do not use the DNBP spray mixture in a young vineyard that is just being established. It will damage succulent growth, such as leaves and young canes, that it contacts.

Do not use volatile forms of 2,4-D, sesone, and TCA herbicides in or near vineyards for any purpose. They are very injurious to grapes.

Do not use spray equipment that has been used to apply 2,4-D or related herbicides on other crops.

reduce the amount of DNBP in the spray and add a residual-type pre-emergence herbicide. To avoid vapor injury and to extend the period of weed control, apply a DNBP-CIPC spray as the second treatment before the weeds emerge again after the first application. Mix 1 pound oil-soluble DNBP and 6 pounds CIPC in 20 gallons of oil plus 80 gallons of water. Spray at a rate

equivalent to 100 gallons per acre.

Simazine, monuron, and diuron can be used to control many germinating annual broadleafed weeds and weedgrasses. In well-established vineyards, apply simazine, monuron, or diuron at 3.2 pounds per acre in the spring before weeds emerge. In some growing areas, a split application of 1.6 pounds of diuron per acre applied in early spring and repeated in late fall is more effective than a single treatment. Apply these herbicides to the soil and be very careful not to spray the grape foliage.

Dalapon is effective in controlling perennial grasses such as Johnson-grass, quackgrass, and Bermuda-grass. Directed sprays of dalapon are used under the grape trellis at 7.4 pounds per acre on actively growing grass. A second dalapon treatment may be applied in the same season. Avoid spraying the grape foliage.

Chemical Names of Herbicides

CIPC.....	Isopropyl N-(3-chlorophenyl) carbamate
DNBP.....	4,6-dinitro ortho-secondary-butylphenol
Dalapon.....	2,2-dichloropropionic acid
Diuron.....	3-(3,4-dichlorophenyl)-1,1-dimethylurea
Monuron.....	3-(<i>p</i> -chlorophenyl)-1,1-dimethylurea
Simazine.....	2-chloro-4,6-bis(ethylamino)- <i>s</i> -triazine

Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over other products not mentioned.

WINTER PROTECTION

Winter protection of grapes may be necessary in very cold areas. Also, varieties that are not completely winter hardy can often be grown beyond their range if protected during the winter.

To provide winter protection, train the trunks of the vines as described under "Modified Chautauqua System," page 14. Then in the fall, bend the trunks and canes to ground and cover with soil, cornstalks, or comparable material.

In arid sections, drying winds during the winter when the vines and ground are frozen often cause severe damage. A windbreak may provide some protection, but covering the plants affords greater protection.

HARVESTING AND FRUIT MATURITY

Color is a poor index of maturity in bunch grapes. Many varieties change color long before they are fully ripe, and practically all varieties become sweeter and less acid as they mature.

For table grapes, maturity is usually determined by taste or by the color of the seeds, which changes from green to brown.

The harvest date for grapes for juice and wine is determined on the basis of the percentage of soluble solids in relation to sugar content. The testing is done with a refractometer or a Balling hydrometer.

Although the highest quality fruit may be obtained by harvest-

ing fully ripened clusters, it is sometimes necessary to harvest the crop before the fruit is fully mature to prevent loss. Some varieties tend to crack after maturity, and rain increases this tendency. On susceptible varieties, ripe-fruit rots spread rapidly during rainy weather. Where the growing season is short, a freeze or frost may damage the crop. In some locations, birds do considerable damage to mature fruit unprotected on the vines. In home plantings, clusters on a few vines can be protected by bagging them with kraft bags or by covering the vines with netting.

INSECTS AND DISEASES

For quality fruit, bunch grapes should be sprayed at least three times to control insects and diseases. Additional applications may be necessary in wet seasons or in areas where certain insects and diseases are more common.

Unsprayed vines in home gardens may occasionally produce fine clusters, but not as a rule. Spraying is easier than removing rotted and insect-infested berries.

Commercial growers must be able to recognize the insects and diseases that are likely to occur in their localities so that they can spray in time to prevent major damage.

For information on insects and diseases, ask your county agricultural agent for a copy of Farmers' Bulletin 1893, "Control of Grape Diseases and Insects in the Eastern United States." Or get a free copy

by sending a post card with the number and title of the publication to the U.S. Department of Agricul-

ture, Washington, D.C. 20250. Include your ZIP Code in your return address.

PRECAUTIONS

Herbicides used improperly may cause injury to man and animals. Use them only when needed and handle them with care. Follow the directions and heed all precautions on the labels.

Keep herbicides in closed well-labeled containers in a dry place. Store them where they will not contaminate food or feed, and where children and animals cannot reach them.

When handling herbicides, wear clean, dry clothing.

Avoid repeated or prolonged contact of herbicide with your skin.

Wear protective clothing and equipment if specified on the container label. Avoid prolonged inhalation of herbicide dust or mist.

Avoid spilling herbicide concentrate on your skin, and keep it out of your eyes, nose, and mouth. If you spill any on your skin, wash it off immediately with soap and water. If you spill it on your clothing, launder the clothing before wearing it again.

After handling a herbicide, do not

eat, drink, or smoke until you have washed your hands and face. Wash your hands and face and any other exposed skin immediately after applying herbicide.

To protect water resources, fish, and wildlife, do not contaminate lakes, streams, or ponds with herbicide. Do not clean spraying equipment or dump excess spray material near such water.

To protect honey bees and other pollinating insects that are necessary in the production of many crops, apply herbicide, when possible, during hours when the insects are not visiting the plants.

Avoid drift of herbicide to nearby wildlife habitats, bee yards, crops, or livestock.

Dispose of empty herbicide containers at a sanitary land-fill dump, or bury them at least 18 inches deep in a level, isolated place where they will not contaminate water supplies. If you have trash-collection service, wrap small containers in heavy layers of newspapers and place them in the trash can.



Use Pesticides Safely
FOLLOW THE LABEL

U.S. DEPARTMENT OF AGRICULTURE